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【Title of Invention】 HIGH-FREQUENCY CURRENT SUPRESSOR OF A TYPE ATTACHED TO A CABLE

【Scope of Claims for Patent】

【Claim 1】 A high-frequency current suppressor of a type attached to a cable characterized in that said high-frequency current suppressor of a type attached to a cable is a flexible member capable of being attached to a cable.

【Claim 2】 A high-frequency current suppressor of a type attached to a cable as claimed in claim 1, wherein said flexible member comprises a break which elongates over all length along an axial direction of said cable.

【Claim 3】 A high-frequency current suppressor of a type attached to a cable as claimed in claim 1 or 2, wherein said high-frequency current suppressor of a type attached to a cable comprises at least two layers which consist of a high-frequency current suppressing layer and at least one outer layer.

【Claim 4】 A high-frequency current suppressor of a type attached to a cable as claimed in claim 3, wherein said outer layer is consisting of either a molded resin or a molded metal, or combination of said molded resin and said molded metal.

【Claim 5】 A high-frequency current suppressor of a type attached to a cable as claimed in any one of claims 1 through 4, wherein said high-frequency current suppressor of a type attached to a cable is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Fe, Si, Al, and binding material.

【Claim 6】 A high-frequency current suppressor of a type

attached to a cable as claimed in any one of claims 1 through 4, wherein said high-frequency current suppressor of a type attached to a cable is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Ni, Fe, and binding material.

【Claim 7】 A high-frequency current suppressor of a type attached to a cable as claimed in any one of claims 1 through 4, wherein said high-frequency current suppressor of a type attached to a cable is consisting of magnetic loss thin film which comprises a first member consisting of at least any one of Fe, Co, Ni, or mixture thereof and a second member consisting of insulating material including at least more than one kinds of elements other than said Fe, Co, Ni.

【Claim 8】 An earphone and / or a headphone for use in a terminal of mobile communication, wherein said earphone and / or a headphone is provided with said high-frequency current suppressor of a type attached to a cable as claimed in any one of claims 1 through 7.

【Detailed Description of the Invention】

【0001】

【Technical Field of the Invention】

The present invention relates to a high-frequency current suppressor of a type attached to a cable for suppressing high-frequency conduction noise in a signal transmission cable used for various electronic information equipment, such as a terminal equipment for mobile communication, or the like, and also to an earphone system or the like / or a headphone system that is provided with said high-frequency current suppressor of a type

attached to a cable for use in a terminal of mobile communication.

【0002】

【Prior Art】

Conventionally, in various terminal equipment for mobile communication, there are earphones or headphones that makes hands-free communication available, namely makes it unnecessary for a user to hold the terminal equipment for mobile communication directly in his hand. Also various signal transmission cables are used for transmitting signals between devices or between components in various electronic information equipment.

【0003】

A cable length of the signal cable ranges from several tens centimeters to a hundred and several tens centimeters. In addition, the cable length corresponds to order of wavelength in microwave band used for mobile communication.

【0004】

【The problem that the invention intends to solve】

An output from antenna attached to a terminal equipment for mobile communication is easily conducted to the signal cable of the earphone system due to electromagnetic coupling. As a result, electromagnetic wave is conducted to a head of the user through the signal cable. This sometimes increases localized SAR (absorbed electric power per specific weight) value.

Thus, electromagnetic waves produced from a terminal equipment for mobile communication or the like cause a problem in which an influence of the electromagnetic waves to a human body becomes serious.

【0005】

Various researches have been made in recent years as regards such an influence of the electromagnetic waves to a human body. It is sure that the influence would become serious problem more and more from now on in accordance with further popularization of the mobile communication equipment.

【0006】

In addition, unnecessary high-frequency noise (current) is sometimes conducted to a signal cable used for transmitting signals between devices or between components in various electronic information equipment. An erroneous operation of electronic information equipment is thereby caused to occur.

【0007】

It is therefore an object of the present invention to provide a high-frequency current suppressor of a type attached to a cable which is capable of being readily attached to an earphone, microphone, a signal cable, or the like, and which can prevent electromagnetic wave from increasing SAR value in a human head by reducing unnecessary high-frequency current generated in the signal cable due to induction of the electromagnetic wave produced from a terminal equipment, and the like.

【0008】

【Means for solving the problem】

According to the present invention, there is provided a high-frequency current suppressor of a type attached to a cable comprising a flexible member capable of being attached to a cable.

【0009】

Further, according to the present invention, there is provided a high-frequency current suppressor of a type attached to

a cable in which the flexible member comprises a break, which elongates over all length along an axial direction of the cable.

【0010】

Further, according to the present invention, there is provided the high-frequency current suppressor of a type attached to a cable which comprises at least two layers which consist of a high-frequency current suppressing layer and at least one outer layer.

【0011】

Further, according to the present invention, there is provided a high-frequency current suppressor of a type attached to a cable in which outer layer is consisting of either a molded resin or a molded metal, or combination of the molded resin and the molded metal.

【0012】

Further, according to the present invention, there is provided the high-frequency current suppressor of a type attached to a cable which is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Fe, Si, Al, and binding material.

【0013】

Further, according to the present invention, there is provided the high-frequency current suppressor of a type attached to a cable which is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Ni, Fe, and binding material.

【0014】

Further, according to the present invention, there is

provided the high-frequency current suppressor of a type attached to a cable which is consisting of magnetic loss thin film which comprises a first member consisting of at least any one of Fe, Co, Ni, or mixture thereof and a second member consisting of insulating material including at least more than one kinds of elements other than Fe, Co, Ni.

【0015】

Further, according to the present invention, there is provided an earphone and / or a headphone for use in a terminal of mobile communication characterized in that the earphone and / or the headphone is provided with the high-frequency current suppressor of a type attached to a cable.

【0016】

【Embodiment for carrying out the Invention】

Hereunder, description is made about embodiments of the present invention.

【0017】

(First Embodiment)

Fig. 1 is an explanation view for showing a high-frequency current suppressor of a type attached to a cable according to a first embodiment of the present invention, Fig. 1 (a) is a schematic perspective view showing the high-frequency current suppressor of a type attached to a cable, Fig. 1 (b) is a schematic perspective view showing a condition in which the high-frequency current suppressor of a type attached to a cable consisting of composite magnetic material is attached to a cable;

【0018】

In Fig. 1(a), a high-frequency current suppressor of a type

attached to a cable 1 is essentially consisting of a composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including Fe, Si, Al, and a binding material. The composite magnetic material is subjected to press molding to have a cylindrical shape having a size of 1.5 mm in inner diameter, 2.65 mm in outer diameter, and 10.0 mm in length. The composite magnetic material has a break 13 which elongates length direction of the cylindrical shape in a part thereof. The composite magnetic material is thereby formed to have flexibility.

【0019】

On the other hand, Fig. 1(b) shows a condition in which the high-frequency current suppressor of a type attached to a cable 1 consisting of this composite magnetic material is attached to a signal cable 12 having a size of approximately 1.5 mm in outer diameter. The high-frequency current suppressor of a type attached to a cable 1 has flexibility. Let the break 13 be opened by a hand or fingers to be attached and fixed to the signal cable 12.

【0020】

Moreover, suppressing effects against high-frequency current was investigated as regards the high-frequency current suppressor of a type attached to a cable according to this embodiment, after the high-frequency current suppressor of a type attached to a cable 1 was fixed to the signal cable 12. As a result, a suppressing effect of -17dB is obtained at such a frequency band of 900 MHz as used for mobile communication while another suppressing effect of -27dB is obtained at such a frequency band of 1.9 GHz as also used therefor.

【0021】

(Second Embodiment)

Fig. 2 is a schematic perspective view for showing a high-frequency current suppressor of a type attached to a cable according to a second embodiment of the present invention;

【0022】

In Fig. 2, a high-frequency current suppressor of a type attached to a cable 2 comprises two layers which consist of a high-frequency current suppressing layer 21 and a resin outer layer 22. The high-frequency current suppressing layer 21 is essentially consisting of a composite magnetic material to have flexibility, similar to that of the first embodiment. An outer circumference of the high-frequency current suppressing layer 21 is covered by the resin outer layer 22 consisting of molded resin having a thickness of approximately 0.5 mm to have flexibility.

【0023】

Also in the high-frequency current suppressor of a type attached to a cable 2, similarly to the first embodiment, both the high-frequency current suppressing layer and the resin outer layer have flexibility. Let the break 23 of the high-frequency current suppressor of a type attached to a cable 2 be opened by a hand or fingers to be attached to the signal cable and release the high-frequency current suppressor of a type attached to a cable 2 from the hand or fingers. Accordingly, the high-frequency current suppressor of a type attached to a cable 2 is adhered and fixed to the signal cable.

【0024】

Further, suppressing effects against high-frequency current was investigated as regards the high-frequency current

suppressor of a type attached to a cable 2, after being fixed to the signal cable. As a result, a suppressing effect of -18dB is obtained at such a frequency band of 900 MHz as used for mobile communication while another suppressing effect of -29dB is obtained at such a frequency band of 1.9 GHz as also used therefor.

【0025】

(Third Embodiment)

Fig. 3 is a schematic perspective view for showing a high-frequency current suppressor of a type attached to a cable according to a third embodiment of the present invention;

【0026】

In Fig. 3, a high-frequency current suppressor of a type attached to a cable 3 comprises two layers which consist of a high-frequency current suppressing layer 31 and an aluminum outer layer 32. The high-frequency current suppressing layer 31 is essentially consisting of a composite magnetic material to have flexibility, similar to that of the first embodiment. An outer circumference of the high-frequency current suppressing layer 31 is covered by the aluminum outer layer 32 consisting of molded aluminum having a thickness of approximately 0.3 mm to have flexibility.

【0027】

Also in the high-frequency current suppressor of a type attached to a cable 3, similarly to the first and second embodiment, both the high-frequency current suppressing layer and the aluminum outer layer have flexibility. Let the break 33 of the high-frequency current suppressor of a type attached to a cable 3 be opened by a hand or fingers to be attached to the signal cable and

release the high-frequency current suppressor of a type attached to a cable 3 from the hand or fingers. Accordingly, the high-frequency current suppressor of a type attached to a cable 3 is adhered and fixed to the signal cable.

【0028】

Further, suppressing effects against high-frequency current was investigated as regards the high-frequency current suppressor of a type attached to a cable 3, after being fixed to the signal cable. As a result, a suppressing effect of -17dB is obtained at such a frequency band of 900 MHz as used for mobile communication while another suppressing effect of -32dB is obtained at such a frequency band of 1.9 GHz as also used therefor.

【0029】

(Fourth Embodiment)

Fig. 4 is a schematic perspective view for showing a high-frequency current suppressor of a type attached to a cable according to a fourth embodiment of the present invention;

【0030】

In Fig. 4, a high-frequency current suppressor of a type attached to a cable 4 has three-layers structure which comprises a high-frequency current suppressing layer 41, a polyimide base material 42 and a resin outer layer 44. The high-frequency current suppressing layer 41 has flexibility and is consisting of magnetic loss thin film (granular magnetic thin film) composed of $Fe_{72}Al_{11}O_{17}$. The polyimide base material 42 has a thickness of approximately 0.2 mm to have flexibility. The resin outer layer 44 is consisting of molded resin having a thickness of approximately 0.5 mm to have flexibility. In order to fabricate these three-layers

structure, at first, the high-frequency current suppressing layer 41 is formed on a surface of the polyimide base material 42 by sputtering to have a film thickness of 1.5 μ m. Thereby, the high-frequency current suppressing layer 41 and the polyimide base material 42 are formed to have a cylindrical shape having approximately 1.5 mm in inner diameter, and approximately 10.0 mm in length. An outer circumference of the high-frequency current suppressing layer 41 is then covered by the resin outer layer 44 consisting of molded resin having a thickness of approximately 0.5 mm to have flexibility.

【0031】

Also in the high-frequency current suppressor of a type attached to a cable 4, similarly to the first through the third embodiments, all of the high-frequency current suppressing layer , the polyimide base material and the resin outer layer have flexibility. Let the break 43 of the high-frequency current suppressor of a type attached to a cable 4 be opened by a hand or fingers to be attached to the signal cable and release the high-frequency current suppressor of a type attached to a cable 4 from the hand or fingers. Accordingly, the high-frequency current suppressor of a type attached to a cable is adhered and fixed to the signal cable.

【0032】

Further, suppressing effects against high-frequency current was investigated as regards the high-frequency current suppressor of a type attached to a cable 4, after being fixed to the signal cable. As a result, a suppressing effect of -23dB is obtained at such a frequency band of 900 MHz as used for mobile

communication while another suppressing effect of -35dB is obtained at such a frequency band of 1.9 GHz as also used therefor.

【0033】

Next, Fig. 5 shows suppressing effects against high-frequency electromagnetic waves in the high-frequency current suppressors of a type attached to a cable 11, 21, 31 and 41 according to the first through the fourth embodiments.

【0034】

In Fig. 5, EXAMPLE 1 shows measuring effects of transmission characteristics by a network analyzer between two ports. In these measuring, the high-frequency current suppressors of a type attached to a cable according to the first through the third embodiments are attached to be fixed to a central portion in the length direction of the cable having 1.5 mm in outer diameter and 300 mm in length. The high-frequency current suppressor of a type attached to a cable is consisting of a composite magnetic material having a size of 1.5 mm in inner diameter, 2.65 mm in outer diameter, and 10.0 mm in length that has a break which elongates length direction of the cylindrical shape in a part thereof. Then, both ends of the cable are connected to the network analyzer, as the above-mentioned two ports.

【0035】

On the other hand, EXAMPLE 2 shows measuring effect of transmission characteristics by a network analyzer between two ports. In this measuring, the high-frequency current suppressor of a type attached to a cable 4 according to the fourth embodiment is attached to be fixed to the central portion of the cable, and then both ends of the cable are connected to the network analyzer,

similarly to the above example.

【0036】

As will be understood from Fig. 5, according to EXAMPLE 1 and EXAMPLE 2, suppressing effects between 20dB and 35dB can be obtained at quasi-microwave band in any high-frequency current suppressors of a type attached to a cable.

【0037】

Besides, other than the high-frequency current suppressors of a type attached to a cable, alternative high-frequency current suppressors of a type attached to a cable can be designed by changing material composition or size thereof. Accordingly, desirable suppressing characteristics can be obtained by adapting the material composition or the size of the high-frequency current suppressors of a type attached to a cable to a cable.

【0038】

Further, other than the high-frequency current suppressors of a type attached to a cable according to the above-mentioned embodiments, it will now be readily possible to put this invention into effect in various other manners. For example, a break was formed to be a substantially straight line parallel to an axis of the cylindrical shape of the high-frequency current suppressors of a type attached to a cable. The break can be formed to have an angle to the axis of the cylindrical shape. In addition, the break can be formed as a curve. Alternatively, the break can be composed of two edges interfitted to each other when the break is closed. In addition, shapes of the high-frequency current suppressors of a type attached to a cable are not limited to the

cylindrical shape. The high-frequency current suppressors of a type attached to a cable can be formed to have a rectangular shape. Further, a member for preventing the cable from slipping or an adhesive layer can be provided at inner side of the cylindrical or the rectangular tube.

【0039】

【Effects of the Invention】

As described above, according to embodiments of the present invention, the high-frequency current suppressors of a type attached to a cable comprises a flexible member capable of being attached to a cable. The high-frequency current suppressors of a type attached to a cable can therefore be readily attached and fixed to a signal cable used for an earphone, a microphone, and the other electronic equipments. It is possible to provide a high-frequency current suppressor of a type attached to a cable which can suppress unnecessary high-frequency current sufficiently and which is thereby effective to solve various EMI (electromagnetic interference) problems. It is also possible to prevent electromagnetic waves from increasing SAR value in a human head by applying the high-frequency current suppressor of a type attached to a cable to earphone, headphone or a signal cable connecting those to a terminal equipment for mobile communication.

【Brief Description of the Drawings】

【Fig. 1】 An explanation view for showing a high-frequency current suppressor of a type attached to a cable according to a first embodiment of the present invention, Fig. 1 (a) is a schematic perspective view showing the high-frequency current suppressor of

a type attached to a cable, Fig. 1 (b) is a schematic perspective view showing a condition in which the high-frequency current suppressor of a type attached to a cable is attached to a cable.

【Fig. 2】 A schematic perspective view for showing a high-frequency current suppressor of a type attached to a cable according to a second embodiment of the present invention.

【Fig. 3】 A schematic perspective view for showing a high-frequency current suppressor of a type attached to a cable according to a third embodiment of the present invention.

【Fig. 4】 A schematic perspective view for showing a high-frequency current suppressor of a type attached to a cable according to a fourth embodiment of the present invention.

【Fig. 5】 A view for showing suppressing effects against high-frequency electromagnetic waves in the high-frequency current suppressor of a type attached to a cable according to the embodiment of the present invention.

【Explanation of the mark】

1, 2, 3, 4 high-frequency current suppressor of a type attached to a cable

11, 21, 31 high-frequency current suppressing layer

12 signal cable

13, 23, 33, 43 break

22, 44 resin outer layer

32 aluminum outer layer

41 high-frequency current suppressing layer

42 a polyimide base material

【Name of Document】 Abstract

【Abstract】

【Problems】 To provide a high-frequency current suppressor of a type attached to a cable which is capable of being readily attached to an earphone, microphone, a signal cable, or the like, and which can prevent electromagnetic wave from increasing SAR value in a human head by reducing unnecessary high-frequency current generated in the signal cable due to induction of the electromagnetic wave produced from a terminal equipment, and the like.

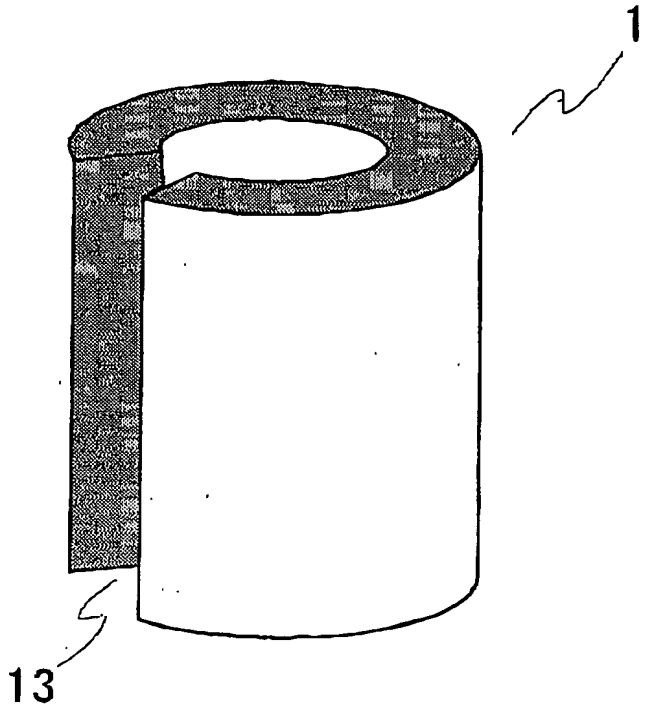
【Solving Means】 According to an aspect of the present invention, there is provided a high-frequency current suppressor of a type attached to a cable 1 capable of being attached to a cable 12, and comprising a flexible member comprises a break 13, which elongates over all length along an axial direction of the cable.

【Drawings】 Fig. 1

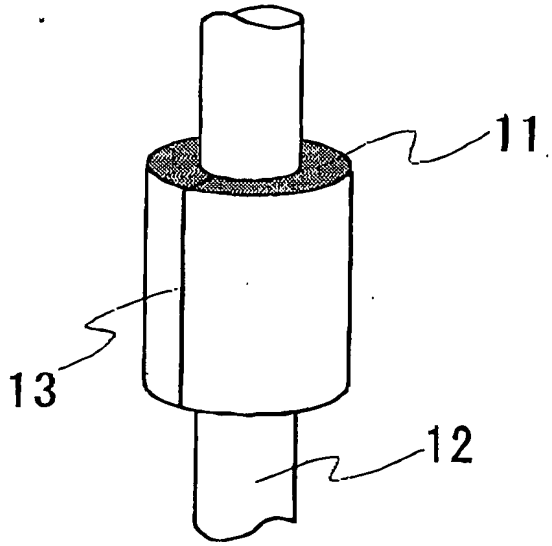
【Name of Document】 Drawings

【Fig 1】

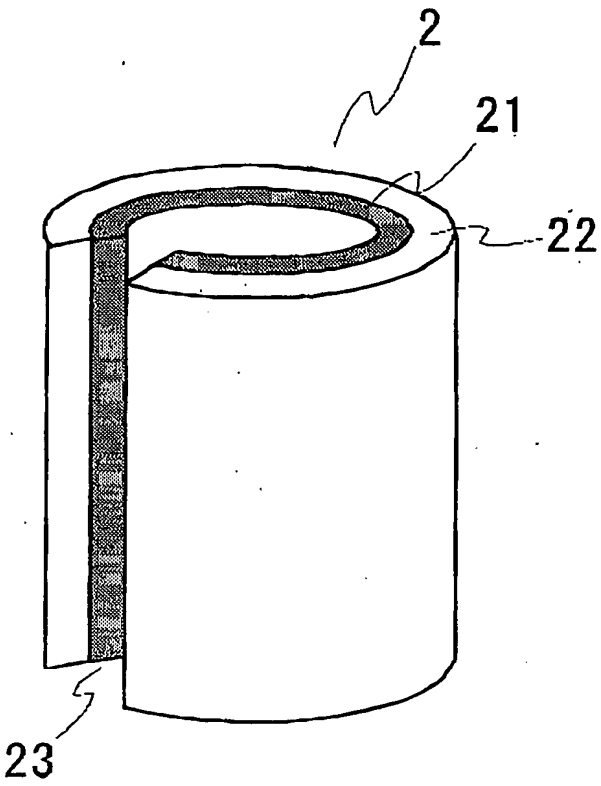
(a)



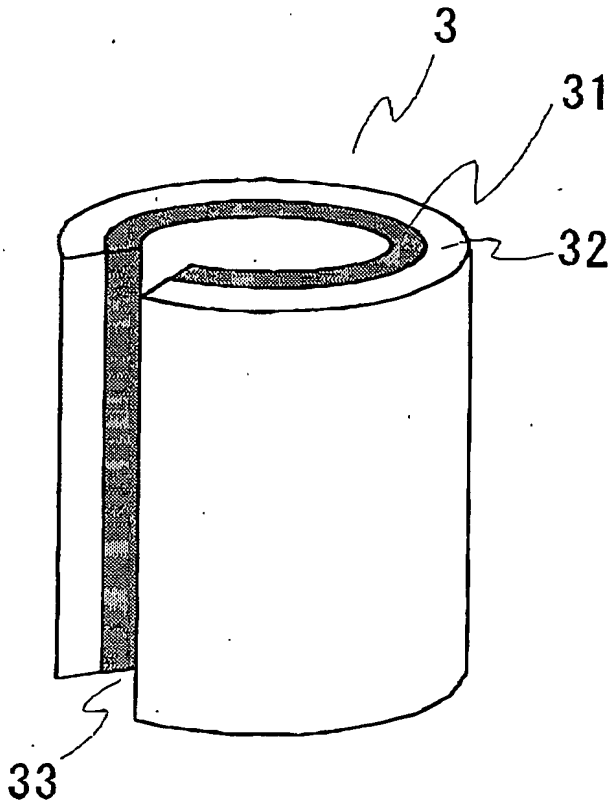
(b)



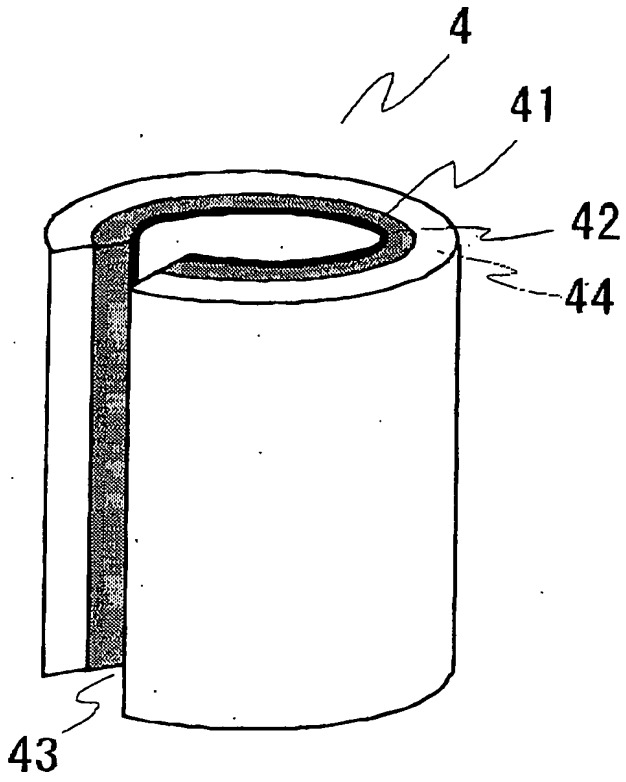
【Fig 2】



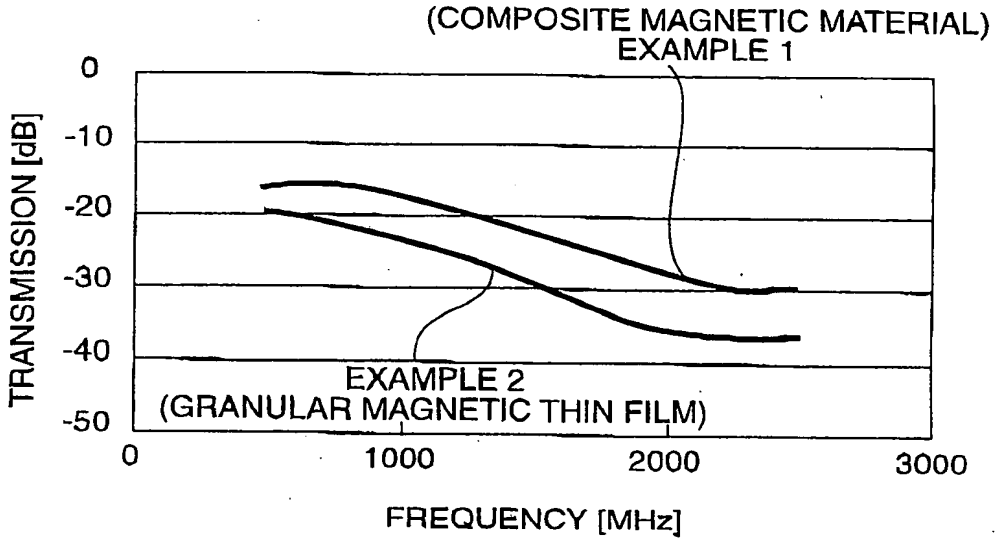
【Fig 3】



【Fig 4】


4
41
42
44
43

【Fig 5】


(COMPOSITE MAGNETIC MATERIAL)
EXAMPLE 1
EXAMPLE 2
(GRANULAR MAGNETIC THIN FILM)
TRANSMISSION [dB]
0
-10
-20
-30
-40
-50
0
1000
2000
3000
FREQUENCY [MHz]